

Primary production investigations in the Saronicos Gulf, 1965-1967

by

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Introduction

During the period 1965 to 1967 a systematic study of the biological productivity of the waters of Saronicos Gulf (Aegean Sea) has been conducted as part of the « Mediterranean Productivity Project » of the NATO Subcommittee on Oceanographic Research. Primary production and related physical and chemical factors were determined at a fixed oceanographic station (referred to as « S₁ »). The station « S₁ » (total depth 150 m) is located about 8 km off the coast of Attica, at 37° 43' N, 23° 46' E.

Previous work at the same station has been reported by BECACOS-KONTOS [1967-1968] and BECACOS-KONTOS & SVANSSON [1969]. They have found no indication of land effect in this area.

The main purposes of this study were 1. to determine the seasonal variations in the rate of primary production in the Saronicos Gulf for the period September 1965 to January 1968 and 2. to study physical and chemical parameters such as temperature, light penetration, nutrients and chlorophyll a which may affect the rate of primary production.

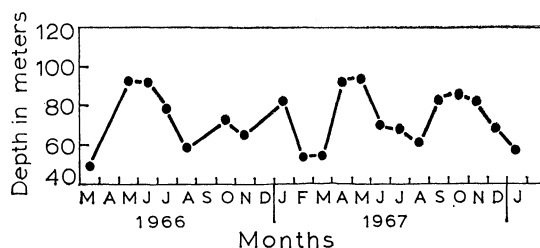


FIG. 1. — Seasonal variation of the depth of the photic layer in Saronicos Gulf during 1966-1967.

Materials and Methods

Water samples were taken with an all plastic water bottle from the standard depths 1, 2.5, 5, 10, 20, 40, 60, 80, and occasionally from 100 meters, between 11.00 and 12.00 hrs local time. At these depths the percentages of illumination (referred to surface) were approximately 100, 90, 85, 75, 50, 25, 15, 5 and 1 % respectively.

The underwater light measurements were made with a selenium underwater photocell using the glass filters BG7 (475 m μ), OGrl (530 m μ) and RG2 (700 m μ) as described by BECACOS-KONTOS & SVANSSON [1969]. Measurements of temperature and salinity were also taken at each sampling depth.

The phosphate determination was performed by the method of MURPHY & RILEY [1962], while nitrate and silicate determinations were made by the methods of STRICKLAND & PARSONS [1965].

Chlorophyll content was determined according to the procedure outlined by SCOR UNESCO (1964). Three liters of sea water were filtered on Cella filters and the extraction was made by 90 % acetone. A FORTRAN program was used to compute chlorophyll concentrations, ratios, and their annual mean values.

Primary production was determined by the *in situ* C^{14} method of STEEMANN NIELSEN [1958]. Ampoules of 4 μ C activity were supplied by « The International Agency for C^{14} Determination ». The filters were also counted by the Agency. The full description of their procedure has been given by BECACOS-KONTOS [1968].

Results and Conclusions

1. *Temperature and salinity.* The waters of Saronicos Gulf were well mixed for approximately 4 months out of the year (January to April). During an annual cycle the temperature ranged from 14.0° C to 26.2° C. The minimum temperature was recorded in March which coincided with the maximum vertical mixing. The maximum temperature was recorded in August. The salinity which ranged from 37.6 to 38.9 ‰ did not show any considerable change during the study period.

2. *Underwater, light penetration.* The 1% value of the surface blue light was found at depths ranging from 50 to 107 meters while the 1 % value of the surface green light was found at depths ranging from 44 to 75 meters. The depth of the photic layer was calculated from these values and found to range from 48 to 94 meters with a mean value of 72 meters. The seasonal variation of the photic layer depth is given in Figure 1. The minimum depth of the photic layer was observed in March with maximum primary production.

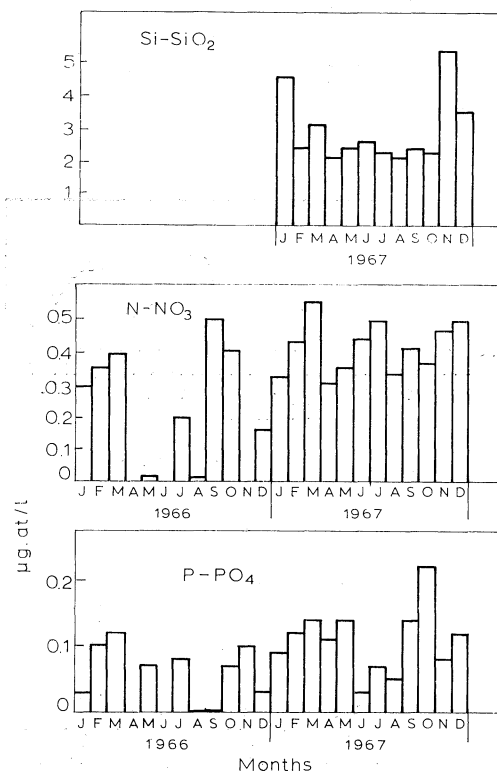


FIG. 2. — Seasonal variations of nutrients in Saronicos Gulf during 1966-1967. Data are integral mean values for the water column of 0-80 m in μ g at/L.

3. *Nutrients.* The seasonal distribution of phosphate, nitrate and silicate is given in Figure 2. The concentrations in μ g at/L are integrated mean values for the water column from 0 to 80 meters. It was found that the integrated mean concentrations ranged from 0-0.23 μ g at/L for phosphate; 0-0.81 μ g at/L

for nitrate and 1.56-6.20 $\mu\text{g at/L}$ for silicate. The seasonal variation of phosphate shows relatively high values in spring and lower values at the beginning of summer. This is most likely a result of stratification. It is evident that... these nutrients influence the rate of primary production in Saronicos Gulf. The low concentrations of both phosphate and nitrate throughout the year indicate the general deficiency of nutrients in the Saronicos Gulf.

4. Chlorophylls. The seasonal variation in chlorophyll *a* is shown in Figure 3. The integrated mean concentrations for all samples analysed were 0.11 mg/m^3 for chlorophyll *a* and 0.10 mg/m^3 for chlorophyll *c*. Both chlorophyll *a* and *c* gave higher values at the surface (2.5 m) samples; the mean concentration for chlorophyll *a* was 0.13 mg/m^3 and for chlorophyll *c* 0.12 mg/m^3 . The other depths gave values of the same order of magnitude. The chlorophyll histogram is dominated by the diatom peak of the spring bloom. At the height of the spring bloom in March, chlorophyll reached its maximum values. Chlorophyll levels were lowest throughout the summer months. The highest chlorophyll concentrations observed were 0.42 and 0.41 mg/m^3 in March 1967 at the depths 2.5 and 20 meters, respectively.

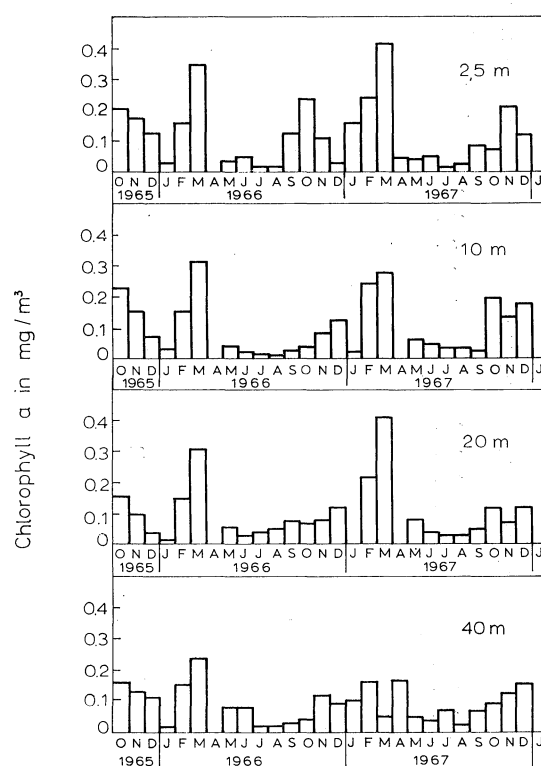


FIG. 3. — Seasonal variation of chlorophyll *a* during 1966-1967 at the depths 2.5, 10, 20 and 40 meters.

5. Primary Production. The seasonal variation in primary production at station « S₁ » integrated for the euphotic zone is shown in Figure 4. The annual gross primary production in Saronicos Gulf was calculated to be 71 $\text{gC/m}^2/\text{year}$ for the period 1965-66 and 66 $\text{gC/m}^2/\text{year}$ for the 1967-68 period with a mean annual value of 69 gC/m^2 . From this value the average daily production was calculated to be 190 $\text{mgC/m}^2/\text{day}$. The dominant feature is the spring bloom in March. It was calculated that production in March is approximately 22 % of the whole year. This maximum production coincided with the chlorophyll maximum and is a result of the nutrient enrichment of the waters caused by vertical mixing which takes place during this period. It is evident that mixing processes which regulate the transportation of nutrients from the bottom to the euphotic zone and the optimum light conditions are the reasons for the higher rate of production during this season. The vertical distribution of primary production gave an average maximum at a depth of 5 meters. The effect of high light intensity in this area resulted in an inhibition of the rate of primary production in the upper layers. This was evident from a lowering of the depth

of maximum production at high light intensities. About 75 % of the total production occurred in the 0 to 40 m layer. Production at 100 m was usually zero. The general conclusion is that the nutrient concentration affects the annual rate of production in the Saronicos Gulf area. The maximum value of production was obtained during a period of vertical mixing under conditions of optimum temperature and light.

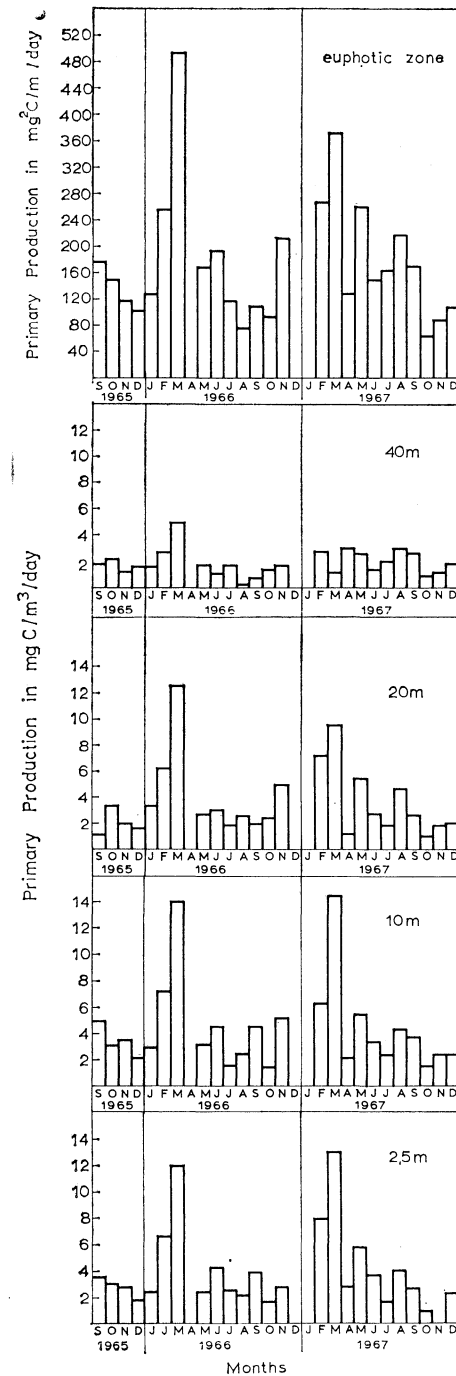


FIG. 4. — Seasonal variation of primary production in Saronicos Gulf during 1965-1966, 1967 at the depths 2.5, 10, 20 and 40 meters and for the whole euphotic zone.

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